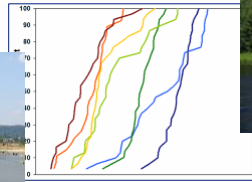# Development of the Fish Assemblage Condition Index (FACI)

Ryan Argo - ORSANCO
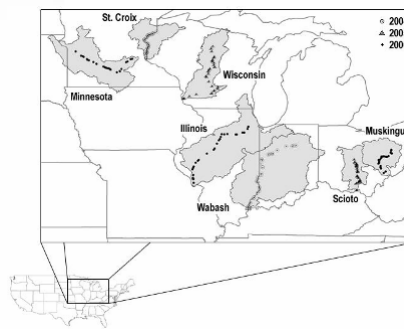
Erich Emery - ORSANCO

REMAP

Regional Environmental Monitoring and Assessment Program

- EPA funded
- Baseline assessment of Ohio & Mississippi river tributaries
- Conducted over 3 years
- 7 of 11 candidate rivers
- Day & Night Electrofishing
- Surveyed Instream Habitat

REMAP Project Objectives

1. Obtain an unbiased assessment of condition
   - Met by calculating MIwb, QHEI, Fish pop/Habitat metrics, and Regional Fish Index (FACI) development
2. Compare our assessment with Region V States (Probability – FACI vs. Targeted – IBIs)
   - Compared scores between the FACI and individual state indices
3. Examine Inter-river variability
   - Compared values between each river
4. Estimate geographic extent and distribution of T/E and exotic/invasive species
   - Provided basin maps detailing species densities and locations

---

Regional Fish Index Development
Fish Assemblage Condition Index (FACI)

1. Determine Abiotic Stressors
   - Identify least disturbed condition (reference sites)
2. Metric Evaluation
   - Range, Responsiveness, and Redundancy
3. Metric Scoring
   - CALU method
4. Index Validation
   - Subset of the data set and comparison to an existing regional index

Determine Abiotic Stressors

- Conducted a PCA of the 30 Abiotic variables
  - Included simple water quality (e.g. ph, DO) and instream habitat variables (e.g. % cover, substrate)
- Abiotic variables were excluded if…
  - > 50% of the sites had the same recorded value
  - ≥ 40% of the sites contained missing values for that particular variable
- Sites were excluded if…
 - Data was absent for any of the 30 abiotic variables

Determine Abiotic Stressors

- Results of the Abiotic PCA   29.1%   18.5%

Abiotic Variable	Definition	Transformation	PC 1	PC 2
QHEI	Qualitative Habitat Evaluation Index		-0.80	-0.05
Secchi	Secchi depth (in)	$Log_{10}(x)$	-0.72	0.02
%Cobble	Percent of site substrate composed of cobble	$Log_{10}(x+1)$	-0.69	0.53
%Gravel	Percent of site substrate composed of gravel		-0.58	0.46
pH	Acidity or Alkalinity of water		-0.50	-0.10
%Sand	Percent of site substrate composed of sand		0.16	-0.89
Temp	Water temperature (°C)		0.22	0.45
DO	Dissolved oxygen (mg/L)	$Log_{10}(x)$	0.25	-0.03
Depth	Average depth (ft)	$Log_{10}(x)$	0.30	0.46
Conductivity	Specific conductivity (µs/cm)		0.46	0.41
%Fines	Percent of site substrate composed of fines	$Log_{10}(x+1)$	0.74	0.38

3

Stressor Gradient
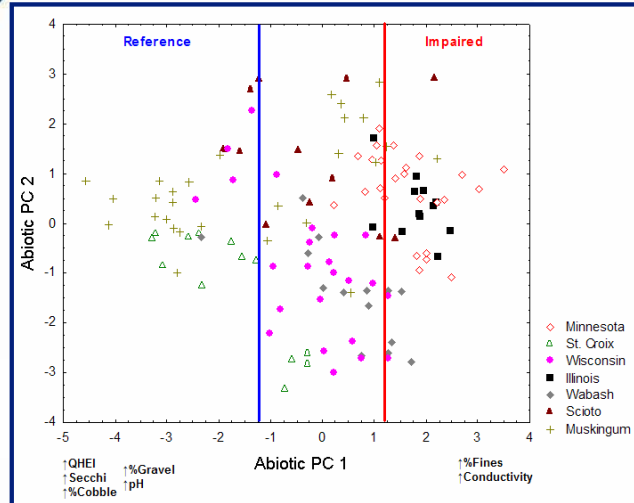
Metric Evaluation

- Categorized fish population data
  - Family, breeding & feeding guild, exotic, hybrid, biomass…etc.
    - Created 113 candidate metrics
- Split the population data
    - **Calibration** – randomly selected 75% of the sites from each river
    - **Validation** – included the remaining 25% from each river
- Metrics were eliminated if they exhibited…
  - Restricted **range** ($\leq$ 5 for richness, $\leq$ 10 for percent)
  - Limited **responsiveness** to the disturbance gradient
 - **Redundancy** with other metrics (| r | >0.80)

Metric Evaluation

Final 12 fish metrics included in the FACI

| Metric Code	Definition	+ / -	5th Percentile	95th Percentile
Ind-T	Total number of individuals excluding tolerant individuals	+	17	464
Sp	Total number of unique species captured	+	9	29
Prop X Sp	Proportion of species that were exotic	-	0	0.177
Prop T	Proportion of all individuals that were tolerants	-	0.013	0.874
Prop INT	Proportion of all individuals that were intolerants	+	0	0.740
Prop RS	Proportion of all individuals that were round-bodied suckers	+	0	0.556
Prop DBS Sp	Proportion of species that were deep-bodied suckers	-	0	0.188
Darters	Number of darter individuals	+	0	32
Prop Carnivore	Proportion of all individuals that were carnivores	+	0	0.316
Prop Generalist Sp	Proportion of species that were generalists	-	0.105	0.35
Prop Herbivore	Proportion of all individuals that were herbivores	-	0	.609
Invertivore kg	Total biomass of all invertivore individuals (kg/ind)	+	0.525	39.793

Metric Scoring

- CALU Method
  - **C**ontinuous scaling (0-100)
  - **A**ll sites are used (Ref and Imp)
  - **L**ower/**U**pper thresholds based on statistical distribution of the data

- Positive metrics

  (Obs. – 5th percentile) / (95th – 5th percentile)*100

- Negative metrics

  (95th percentile – obs.) / (95th – 5th percentile)*100

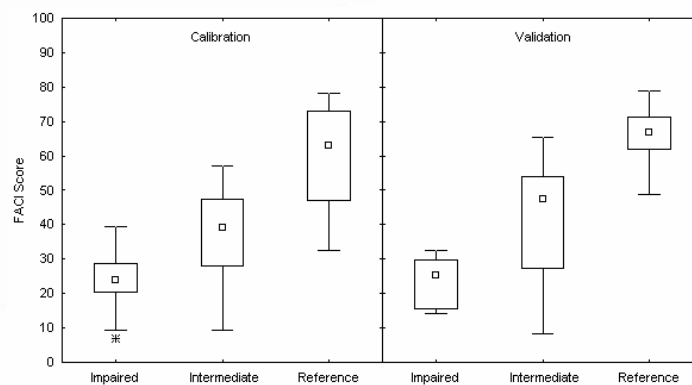- Total FACI Score (max score = 100)

  (∑ All 12 metric scores) / 12
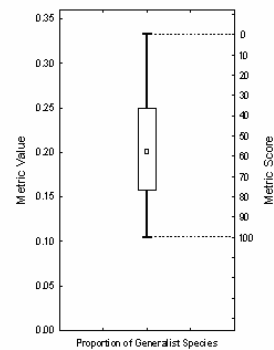
Index Validation
Calibration vs.Validation Data Set
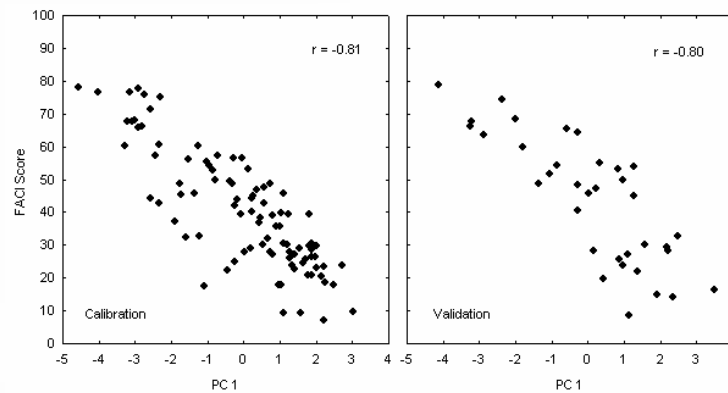
Index Validation
Calibration vs.Validation Data Set

River Basin Condition

	Illinois	Minnesota	Muskingum	Scioto	St. Croix	Wabash	Wisconsin
Total Watershed Area (km²)	74603.20	43714.70	20817.10	16879.80	20030.20	28232.70	30888.50
Natural Cover (%)							
Deciduous Forest	10.03	3.95	40.23	25.94	37.64	45.27	36.39
Evergreen Forest	0.44	0.08	1.92	0.59	3.51	1.57	3.88
Mixed Forest	0.07	0.16	0.73	0.17	4.74	0.55	5.47
Woody Wetlands	1.51	0.72	0.58	0.22	10.37	0.13	7.29
Emergent Wetlands	0.40	4.32	0.33	0.11	5.289	0.53	2.28
Grasslands / Herbaceous	0.80	0.20	0.00	0.00	0.36	1.09	0.37
Bare Rock / Sand / Clay	0.03	0.00	0.00	0.00	0.00	0.00	0.02
Scrubland	0.01	0.05	0.00	0.00	0.07	0.00	0.00
Transitional	0.00	0.01	0.10	0.04	0.85	0.03	0.31
Open Water	1.46	2.54	1.46	0.76	3.73	2.82	3.31
Anthropogenic Land Use (%)							
Row crops	65.46	70.27	18.21	48.69	15.99	29.11	17.11
Pasture / Hay	12.99	14.83	32.25	18.22	16.39	10.89	22.23
Commercial / Industry	1.25	0.67	0.77	1.35	0.32	2.12	0.56
Urban / Recreational Grasses	1.21	0.36	0.31	0.84	0.23	0.50	0.21
High Intensity Residential	2.15	0.21	0.30	0.55	0.06	0.80	0.17
Low Intensity Residential	1.87	0.77	2.62	2.44	0.29	4.55	0.37
Quarries / Strip mines	0.09	0.05	0.20	0.10	0.03	0.06	0.04

Relative Condition
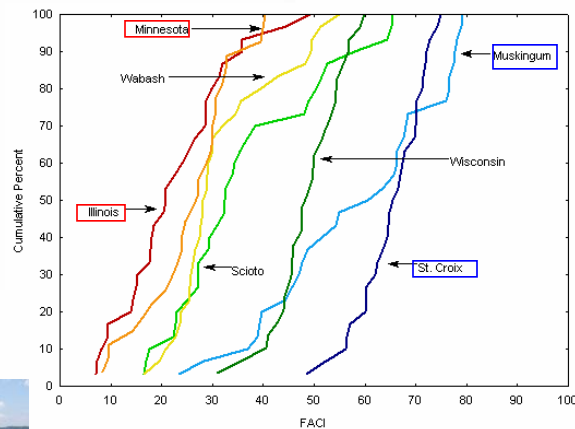
REMAP Project Objectives

1. Obtain an unbiased assessment of condition
   - Met by calculating MIwb, QHEI, Fish pop/Habitat metrics, and *Regional Fish Index (FACI) development*
2. Compare our assessment with Region V States (Probability – FACI vs. Targeted – IBIs)
   - *Compared scores between the FACI and individual state indices*
3. Examine Inter-river variability
   - Compared values between each river
4. Estimate geographic extent and distribution of T/E and exotic/invasive species
   - Provided basin maps detailing species densities and locations

---

State IBI Comparison

- IBI scores were obtained from 7 state agencies for sites which were…
  1. Sampled during the same year as REMAP
  2. Overlapped the REMAP sites
  3. Sampled using their own sampling methods

- To compare our assessment to that of the states we…
  1. Paired sites based on location and time
  2. Calculated % of maximum achievable IBI score for each site
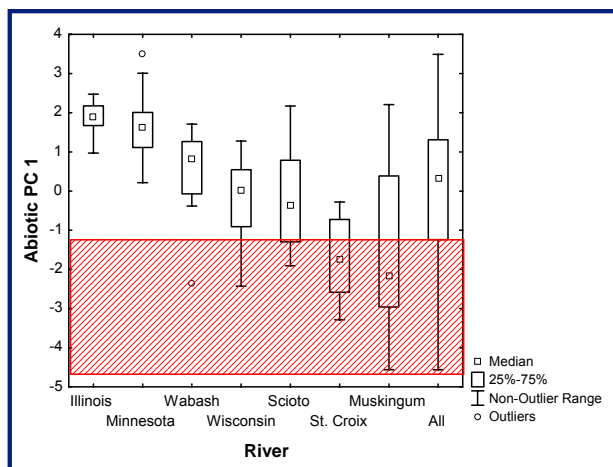 3. Compared IBI scores to our FACI scores

FACI vs. State IBIs
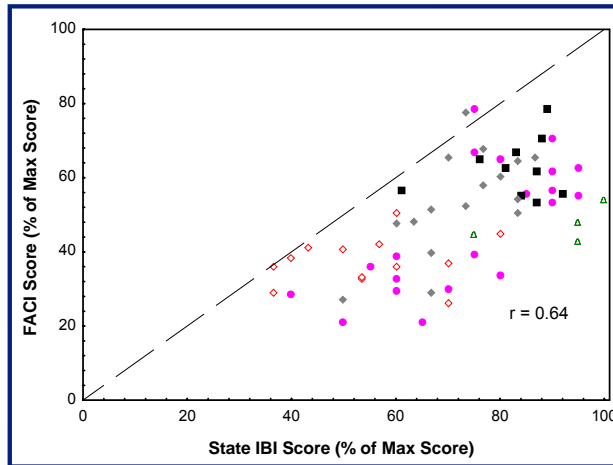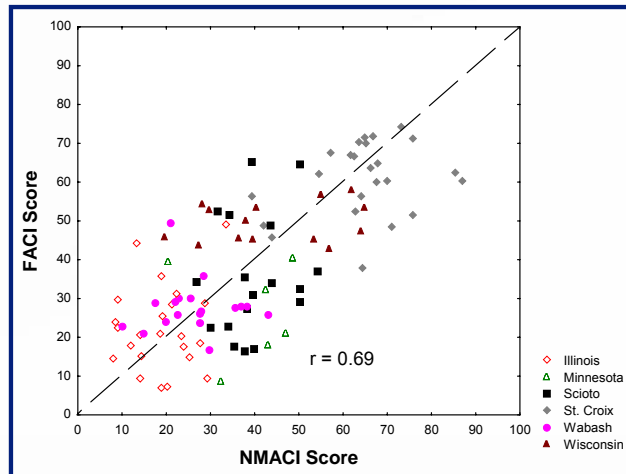

↑ Scale = ↓ Resolution

Regional Indices

Conclusions

- It is possible to develop a *meaningful* IBI at a regional scale using data generated from a probability-based sampling design.
  - General agreement with 'local' IBIs
  - Changing spatial scales can result in changing the range of abiotic condition
    - IBIs and assessment results are only relevant at the scales for which they were developed!

Questions?